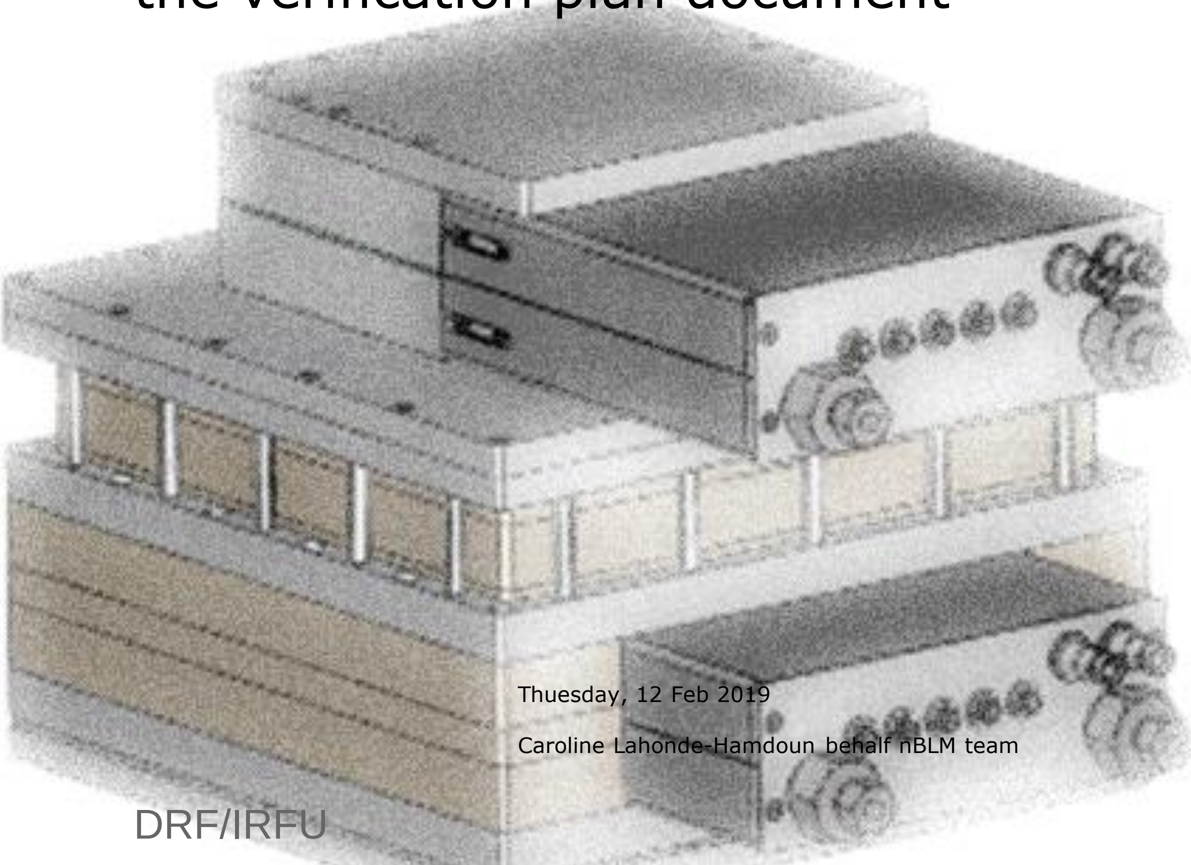
DE LA RECHERCHE À L'INDUSTRIE

nBLM

CDR1.2

Introduction to the verification plan document



Thuesday, 12 Feb 2019

Caroline Lahonde-Hamdoun behalf nBLM team

DRF/IRFU

Laura, Thomas, Irena, Clement, Quentin, Stéphan, Mariam, Helder, Daniel, Michel, Alain, Philippe, Jacques, Françoise, Tom, Victor, Yannick, Pascal, Olivier, Joël, Françoise, etc.

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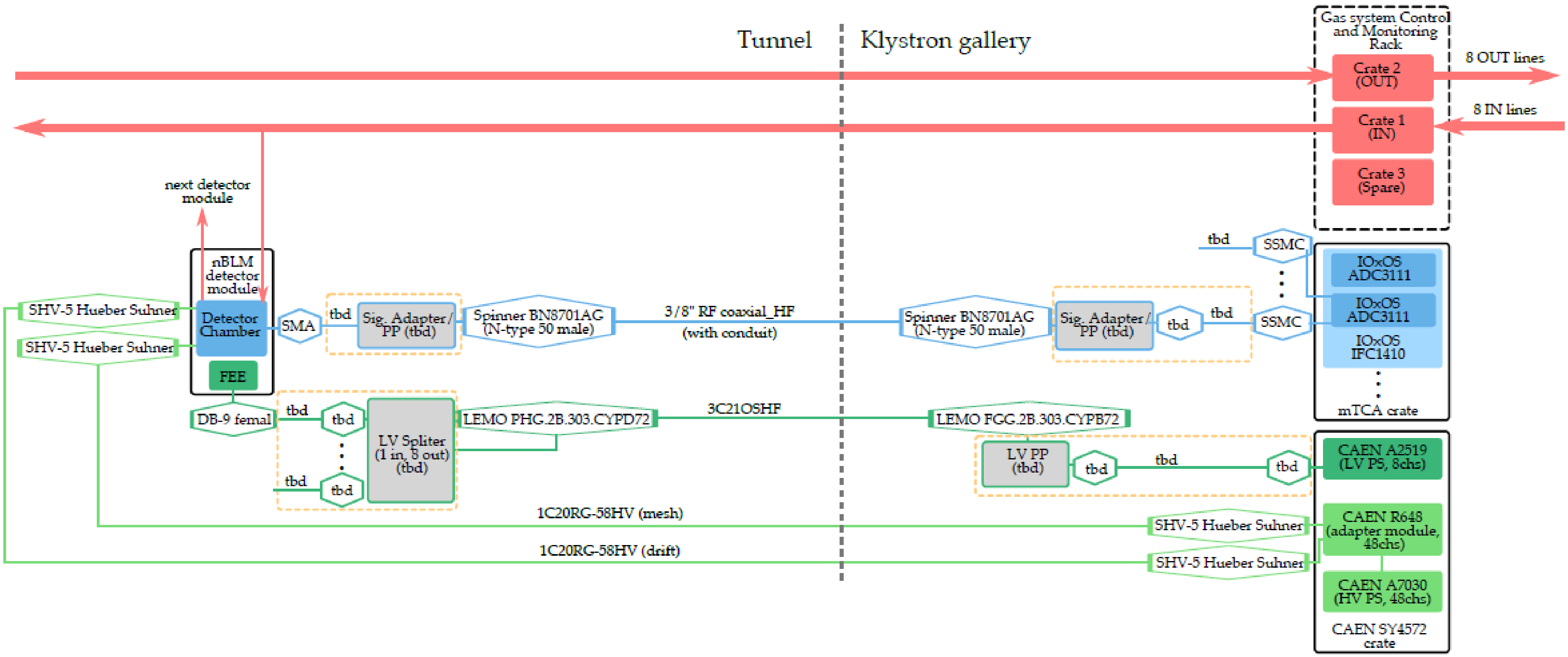
DOCUMENT PURPOSE

"an nBLM testbench and test plan is defined as the complete system needs to be verified for the nBLM installation in ESS"

This is the first version and it is preliminary.
Each detector will be identified in a database (included each various reception of each subsystem, integration and validation test documents).
These documents and the expected values are being finalized and will be updated in the coming months when the various systems are received and during the first assembly / verification test.

NBLM SYSTEM (1 DETECTOR)

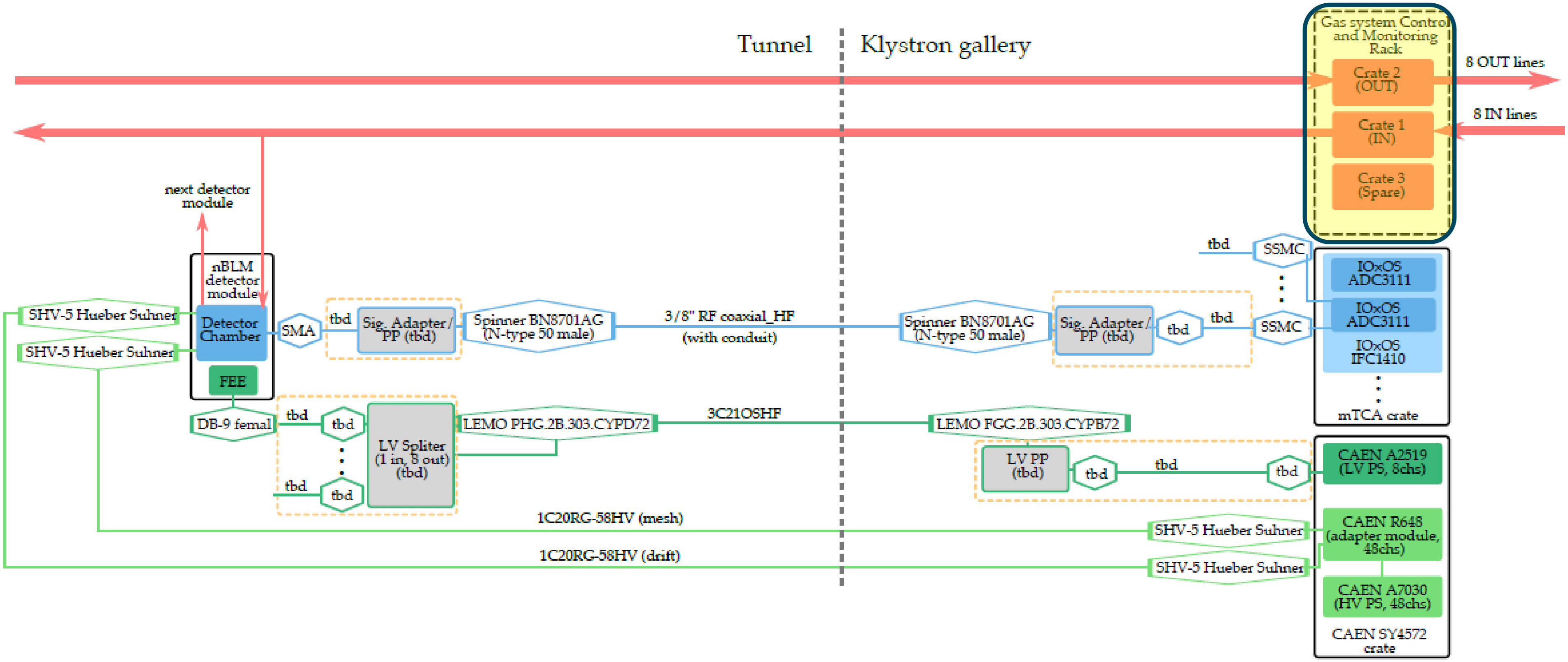


@Irena

NBLM INSTRUMENTS FOR TEST BENCH

Test instruments: list here all Gen/Meas instruments used in the system verification. Uncertainties on each test result are traced back to each instrument using this table			
Instrument ID	Instrument type	Link to Database	Used in:
	DMM		
TBD	oscilloscope	TBD	Detector, electronic systems validation
TBD	Rad source	TBD	Detector validation
TBD	MCA	TBD	Detector validation
TBD	Multimeter	TBD	
TBD	High voltage probe	TBD	HV card validation
TBD	Pulse generator and card test bench	TBD	FEE validation
TBD	Desktop HV power supply	TBD	Detector validation
TBD	Gas leak detector	TBD	Detector validation
TBD	microTCA	TBD	Detector validation
TBD	More instruments	TBD	TBD

GAS RACK



@Irena

GAS RACK

Gas distribution : first two racks
managing the general input and output line
the distribution rack that will control 3 IN and 3 OUT distribution lines

Inner part of the main gas rack

View of the back panel with the electrical connections and output of the distribution gas lines.

@Quentin

GAS RACK

Gas rack first two chassis

put line

trol 3 IN and 3 OUT

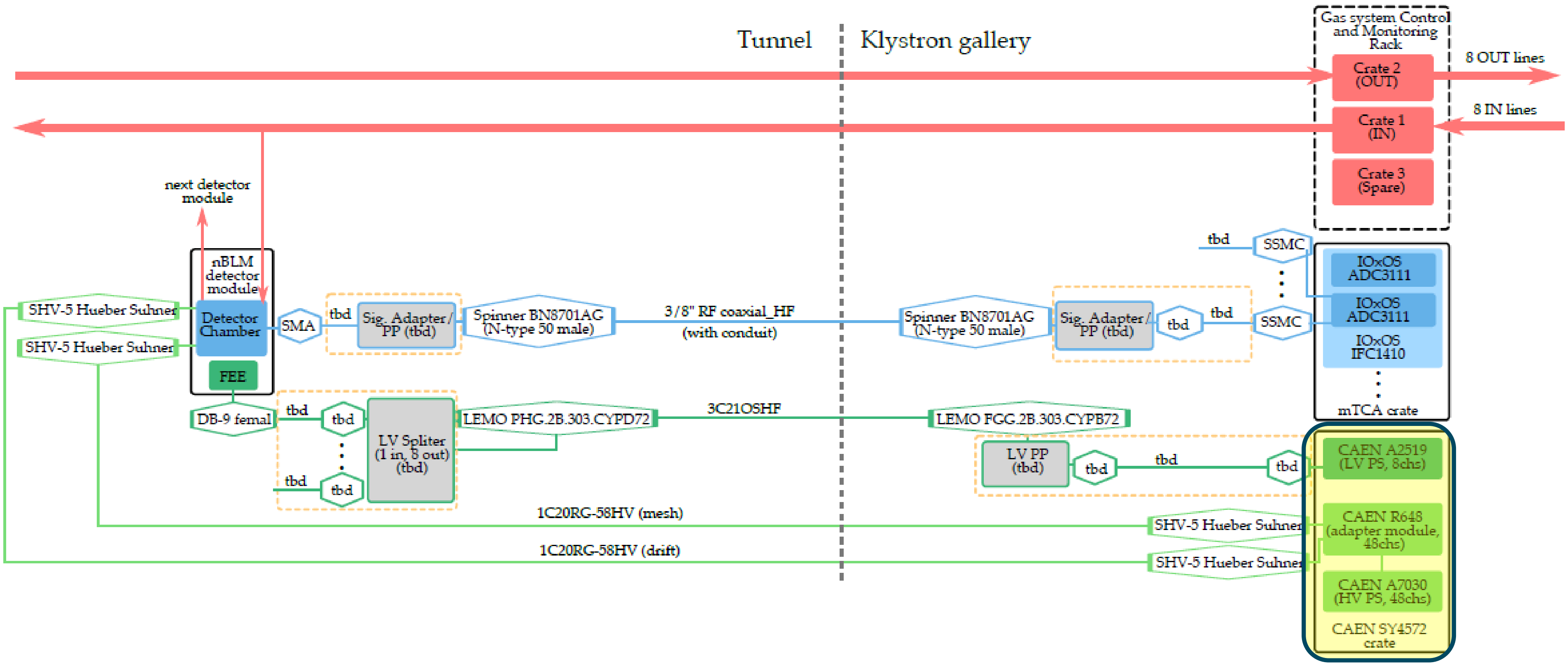
Gas rack Part ID: NA				
Detailed tests results document: TBD				
Note:				
Test ID	Verification procedure	Threshold	Result	Pass / Fail
nBLM_1	Tightness verification Company certification for each rack	TBD		
nBLM_2	**Visual inspection**. Check visually the mechanical assembly for any apparent damage and/or wrong assembly versus assembly drawings	No apparent damage		
nBLM_3	Connect gas rack to power supply.	TBD		
nBLM_4	Check **digital inputs**. Switch 0 to 1 and 1 to 0 and check PLC readback signal with Siemens TIA Portal.	TBD		
nBLM_5	Repeat nBLM_2 for each digital input channel.	TBD		
nBLM_6	Check **analog inputs**. Check PLC readback signal and converted signal with Siemens TIA Portal.	TBD		
nBLM_7	Repeat nBLM_4 for each analog input channel.	TBD		
nBLM_8	Check **digital outputs**. Control channel with Siemens TIA Portal and check the equipment state.	TBD		
nBLM_9	Repeat nBLM_6 for each digital output channel.	TBD		
nBLM_10	Check **analog outputs**. Control channel (3 values: 0%, 50%, 100%) with Siemens TIA Portal and check the equipment state.	TBD		
nBLM_11	Repeat nBLM_8 for each analog output channel.	TBD		

nections and

Inner of the main gas

@Quentin

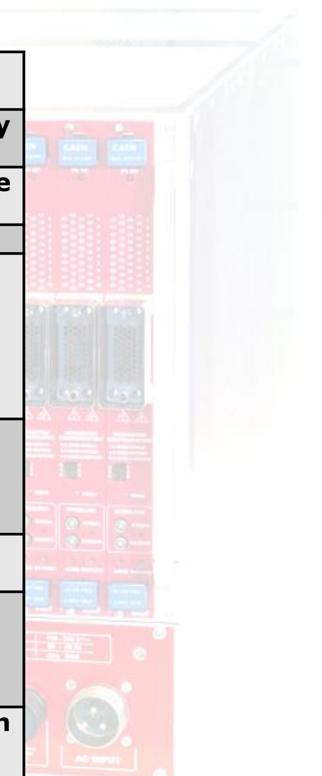
POWER SUPPLY



@Irena

POWER SUPPLY

POWER SUPPLY

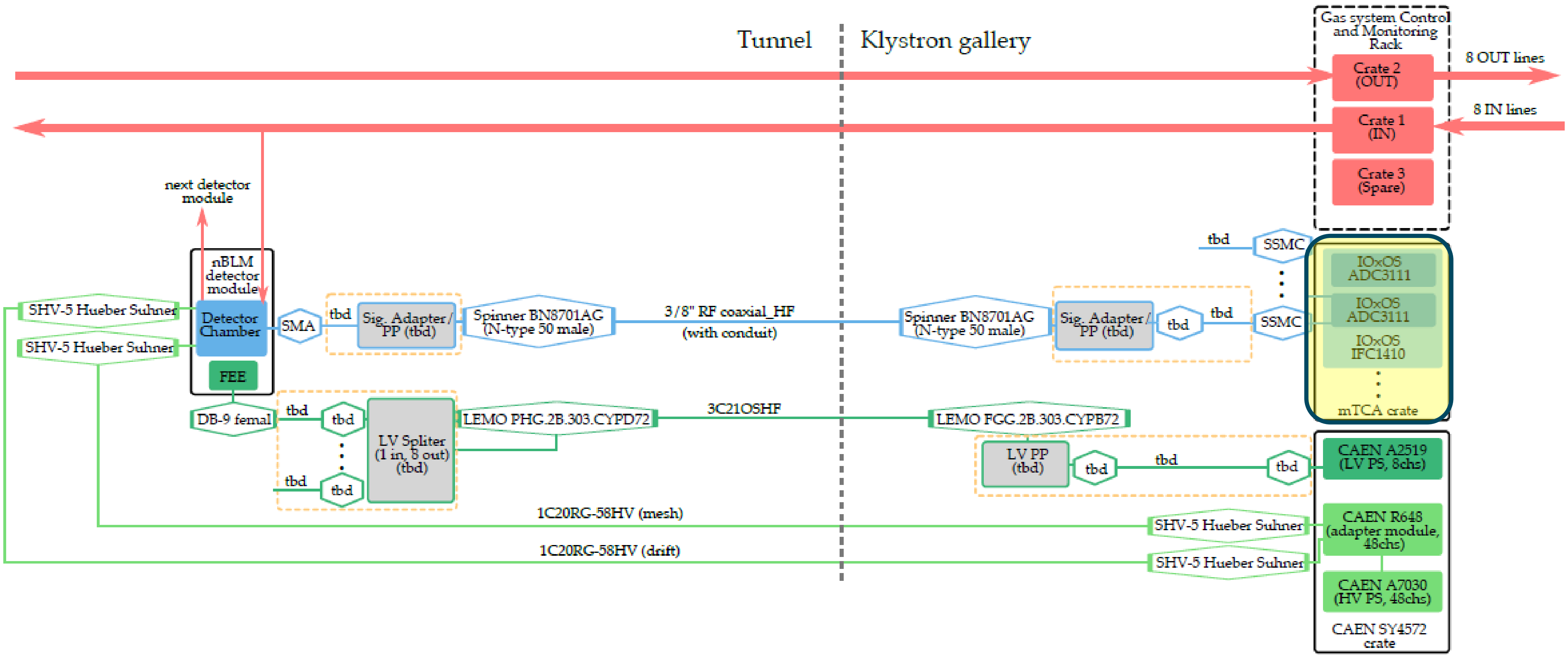


HV supply Part ID: NA				
Detailed tests results document: links on CHESS, if applicable: Metrology results, any detailed tests report.				
Note: The tests described below must be performed sequentially upon reception of the system				
Test ID	Verification procedure	Threshold	Result	Pass / Fail
nBLM_1	**Visual inspection**. Check visually the mechanical assembly for any apparent damage and/or wrong assembly versus assembly drawings	No apparent damage		
nBLM_2	Install HV unit, connect load (detector or ~ 100pF capacitance, apply test voltage on mesh detector / capacitance. **Readout current**	V_mesh = 400 V, σ_i ≤ 10 nA		
nBLM_3	apply test voltage on drift detector. Readout current	V_drift = 600 V, σ_i ≤ 10 nA		
nBLM_4	apply test voltage on mesh and drift detector. **Readout current**	V_mesh = 400 V, σ_i ≤ 10 nA, V_mesh = 400 V, σ_i ≤ 10 nA		
Review pass/fail results: possible risks assessment when test is not passed etc. Explain why a particular step is ignored (if applicable)				

POWER SUPPLY

LV supply Part ID: NA				
Detailed tests results document: links on CHESS, if applicable: Metrology results, any detailed tests report.				
Note: The tests described below must be performed sequentially upon reception of the system				
Test ID	Verification procedure	Threshold	Result	Pass / Fail
nBLM_1	**Visual inspection**. Check visually the mechanical assembly for any apparent damage and/or wrong assembly versus assembly drawings	No apparent damage		
nBLM_2	**Current readout** with LV on and FEE connected	TBD		
nBLM_3	**Voltage readout** with LV on and FEE connected	TBD		
Review pass/fail results: possible risks assessment when test is not passed etc. Explain why a particular step is ignored (if applicable)				

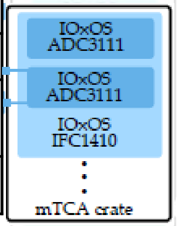
DIGITIZER UNIT



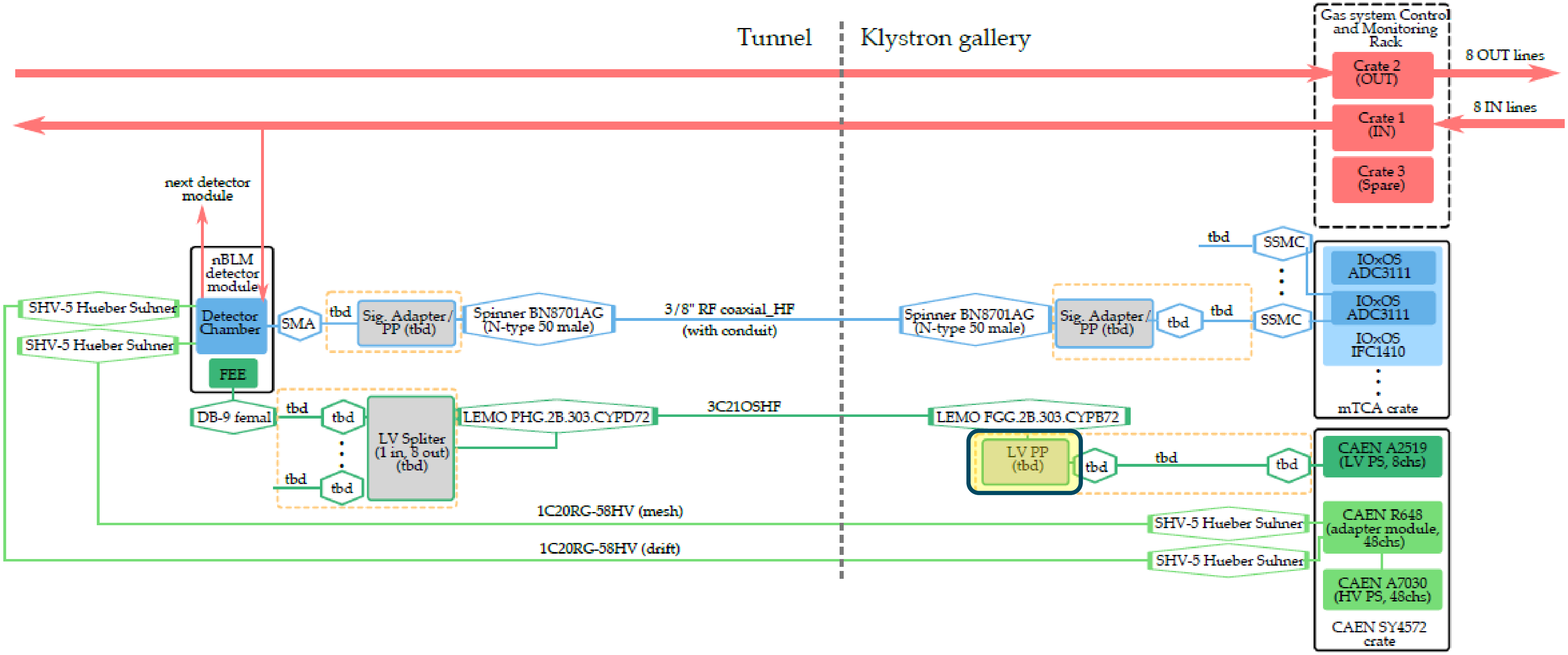
@Irena

DIGITIZER UNIT

Digitizer unit Part ID: NA				
Detailed tests results document: links on CHESS, if applicable.				
Note: These tests are performed separately, upon reception of the AMC. Tests results exchange with ICS is tbd.				
Test ID	Verification procedure	Threshold	Result	Pass / Fail
nBLM_1	ADC SNR	ADC SNR >65 dBc		
nBLM_2	ADC SFDR	65 dBc		
nBLM_3	ADC SINAD	60 dBc		
nBLM_4	ADC ENOB	11.5 bits		
nBLM_5	Crosstalk	< 0.1% FS		
Review pass/fail results: possible risks assessment when test is not passed etc. Explain why a particular step is ignored (if applicable)				

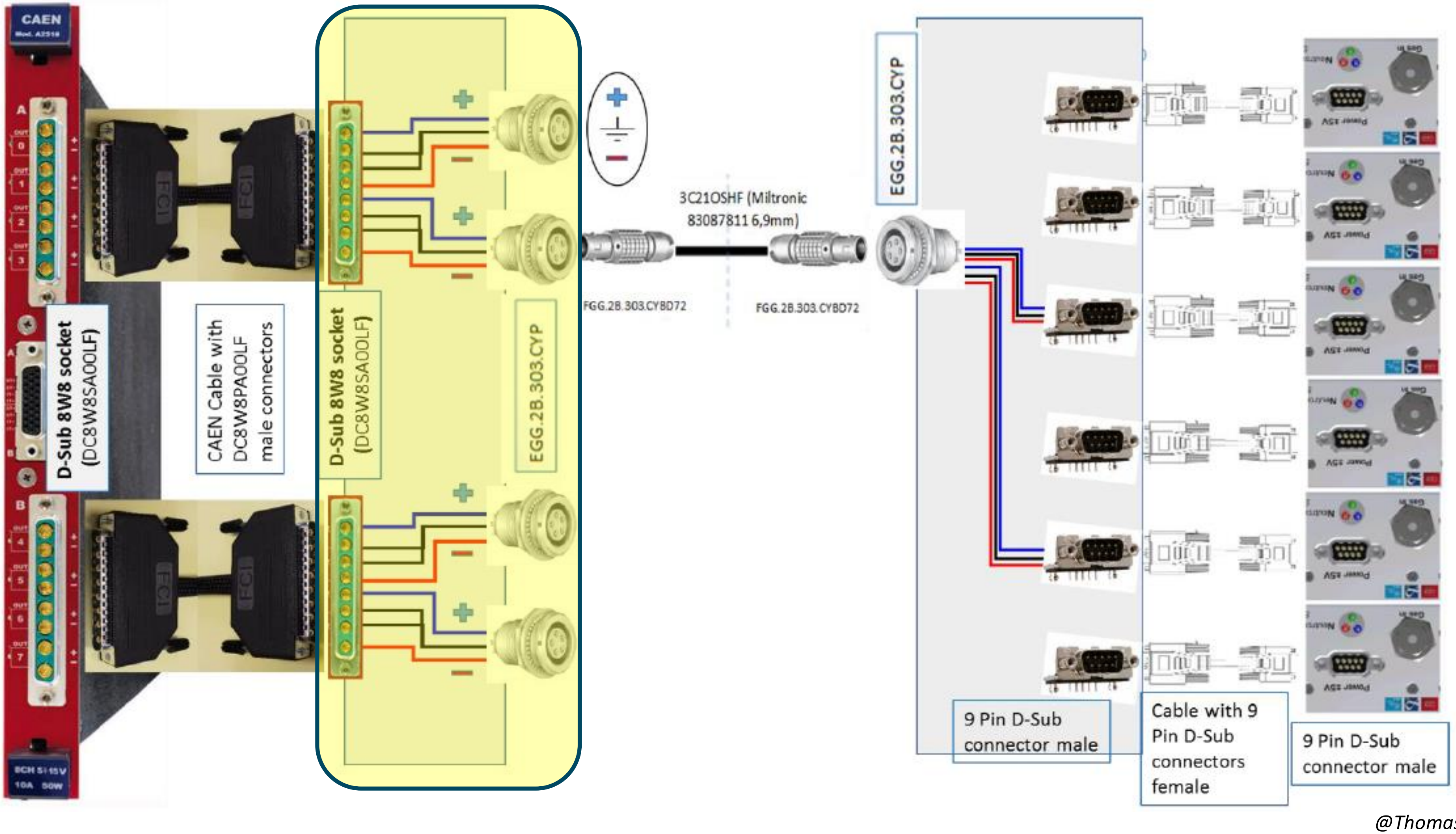


LV PATCH PANEL



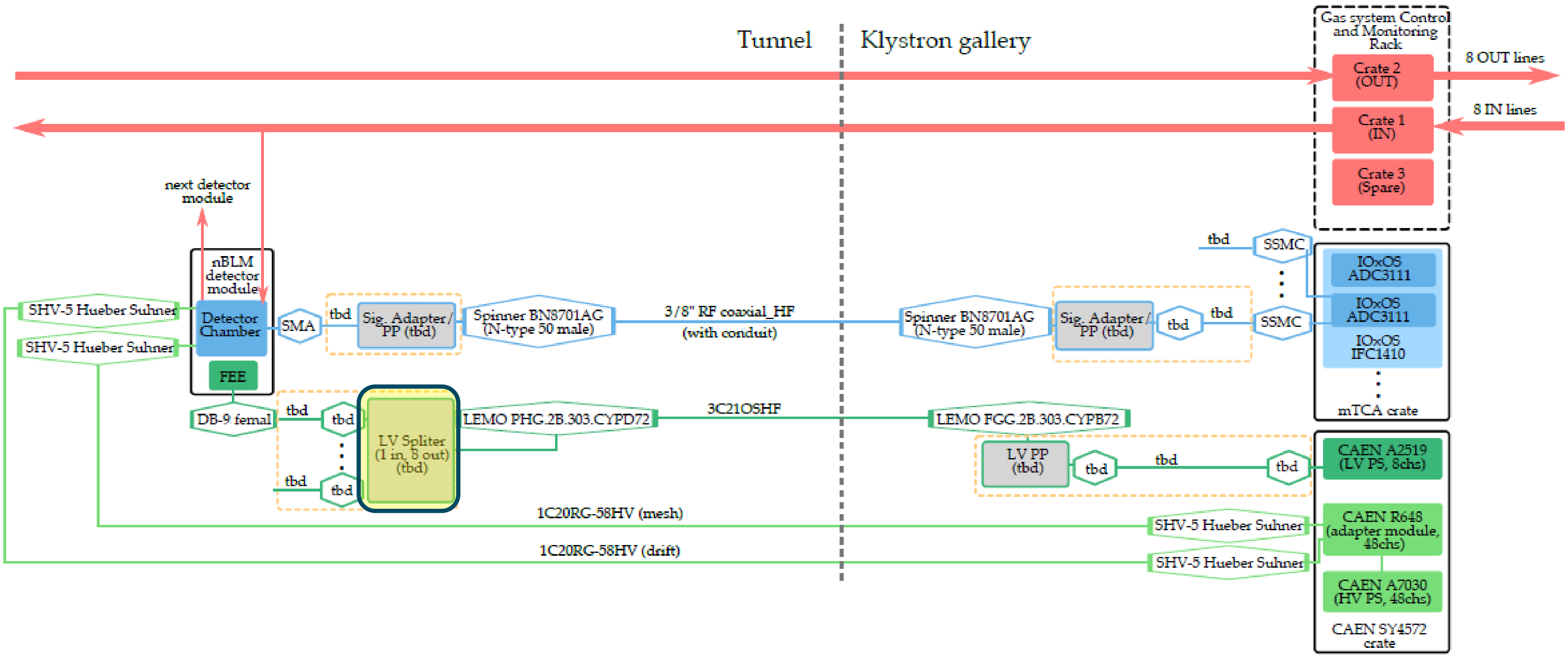
@Irena

LV PATCH PANEL



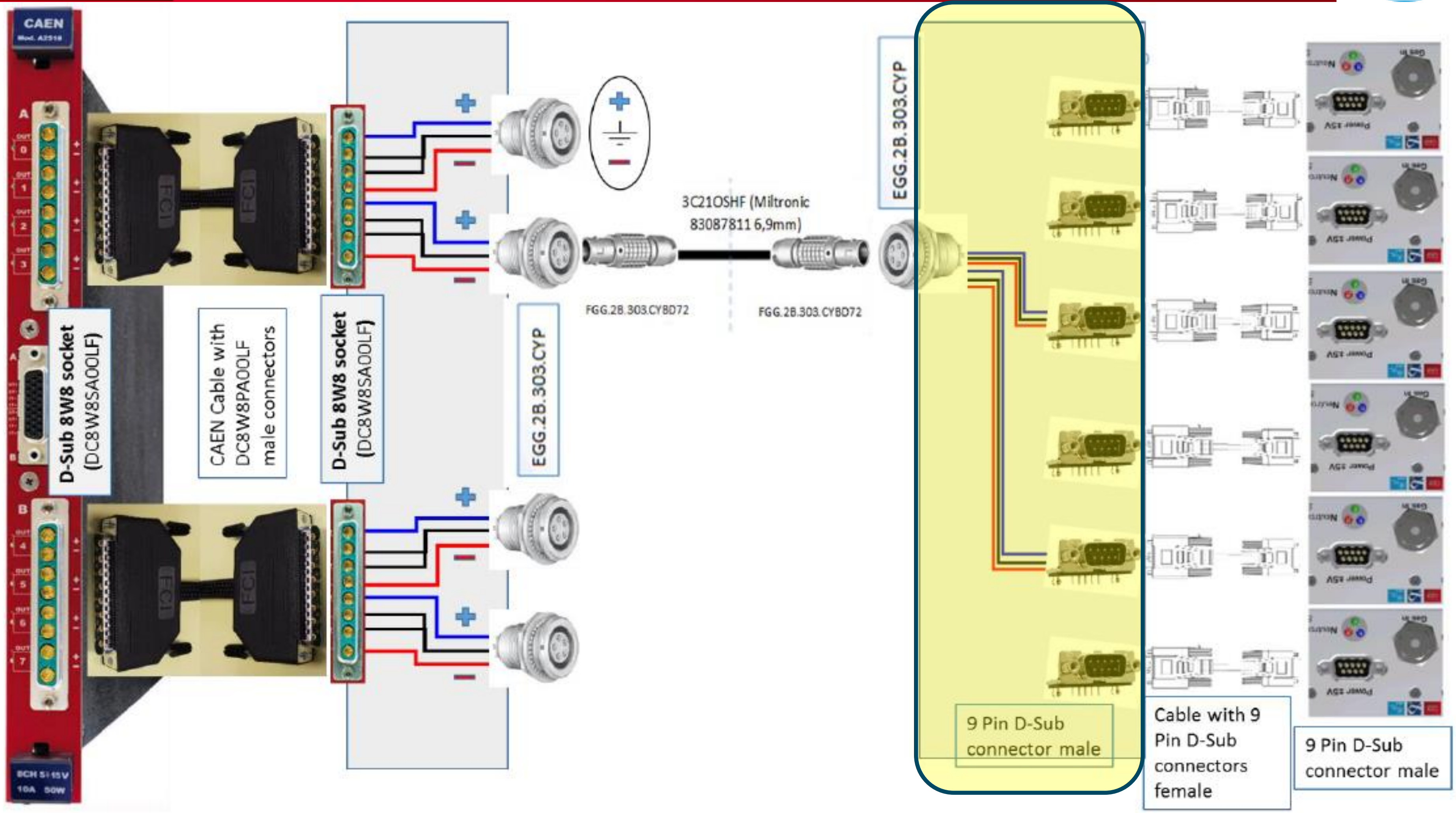
schematic of the nBLM detectors LV layout.

LV SPLITTER



@Irena

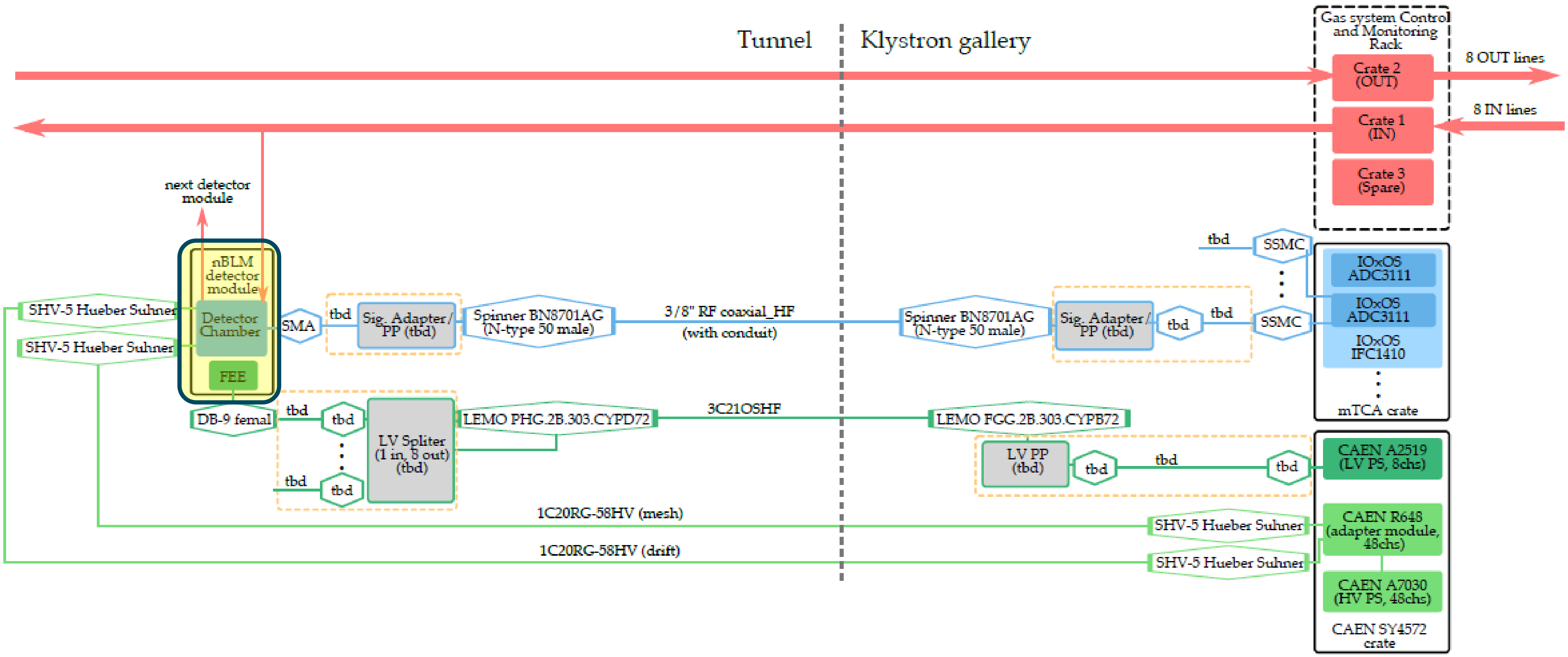
LV SPLITTER



@Thomas

schematic of the nBLM detectors LV layout.

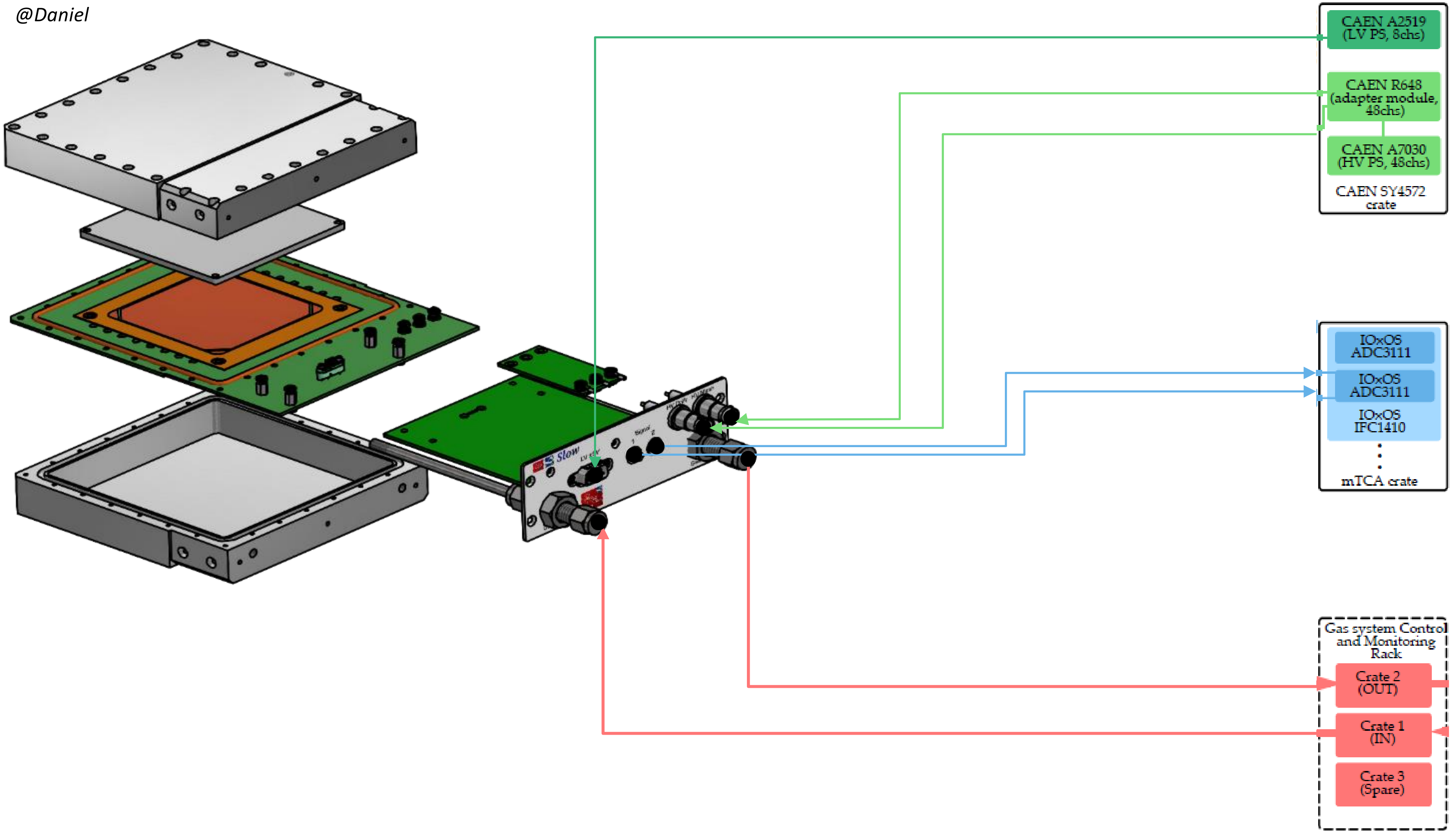
DETECTOR UNIT



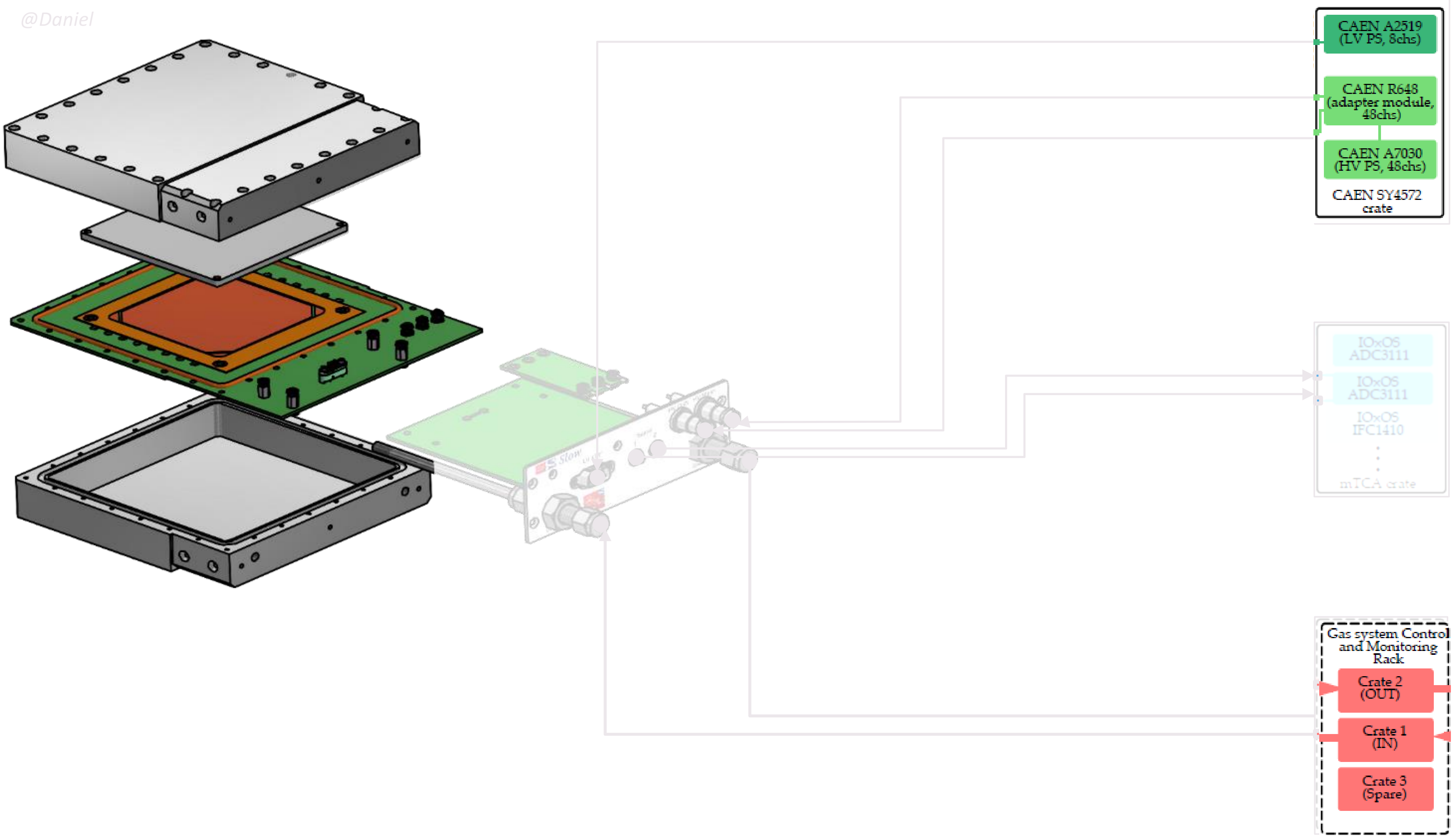
@Irena

DETECTOR UNIT

@Daniel

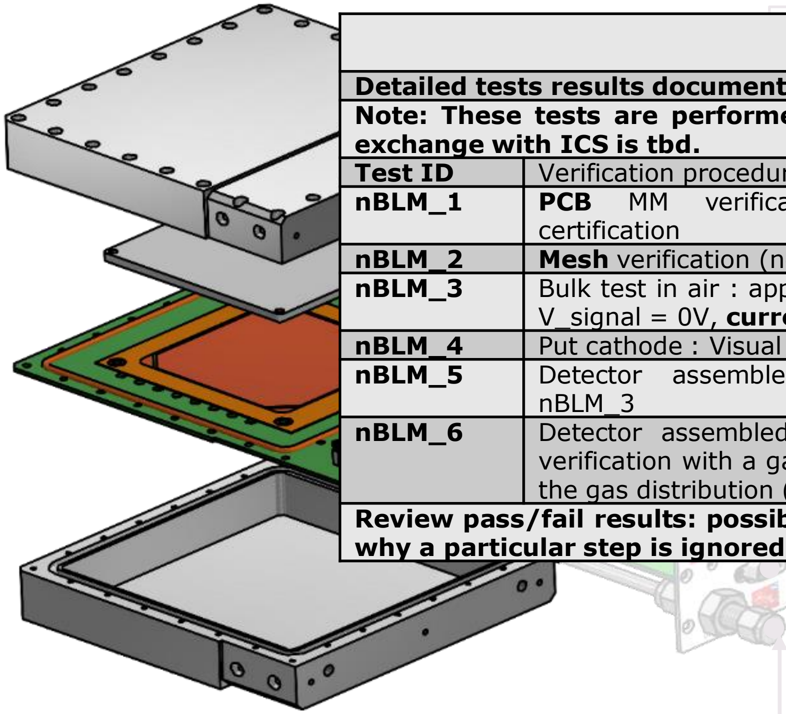


DETECTOR UNIT

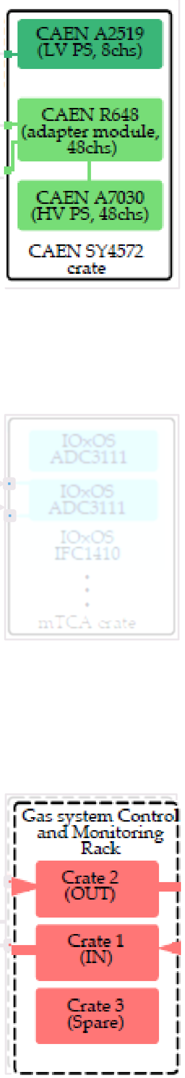


DETECTOR UNIT

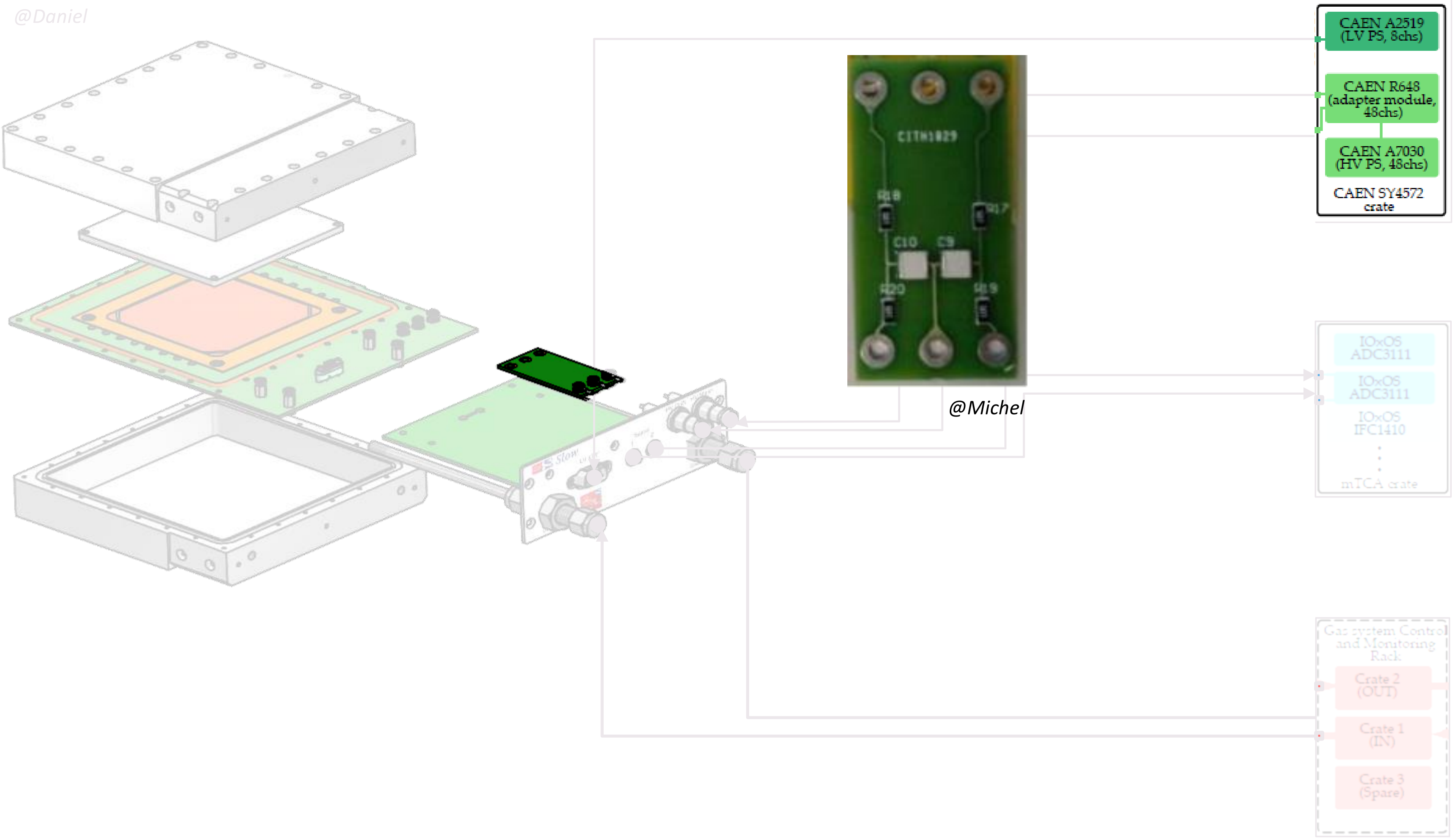
@Daniel



Detector Part ID: NA				
Detailed tests results document: links on CHESS, if applicable.				
Note: These tests are performed separately, upon reception of the AMC. Tests results exchange with ICS is tbd.				
Test ID	Verification procedure	Threshold	Result	Pass / Fail
nBLM_1	**PCB** MM verification : company certification	TBD		
nBLM_2	**Mesh** verification (non damage)	TBD		
nBLM_3	Bulk test in air : apply V_mesh = 900V, V_signal = 0V, **current readout**	I < 10 nA		
nBLM_4	Put cathode : Visual inspection	TBD		
nBLM_5	Detector assembled : repeat step nBLM_3	TBD		
nBLM_6	Detector assembled : **gas tightness** verification with a gas leak detector and the gas distribution (crate n°3)	TBD		
Review pass/fail results: possible risks assessment when test is not passed etc. Explain why a particular step is ignored (if applicable)				



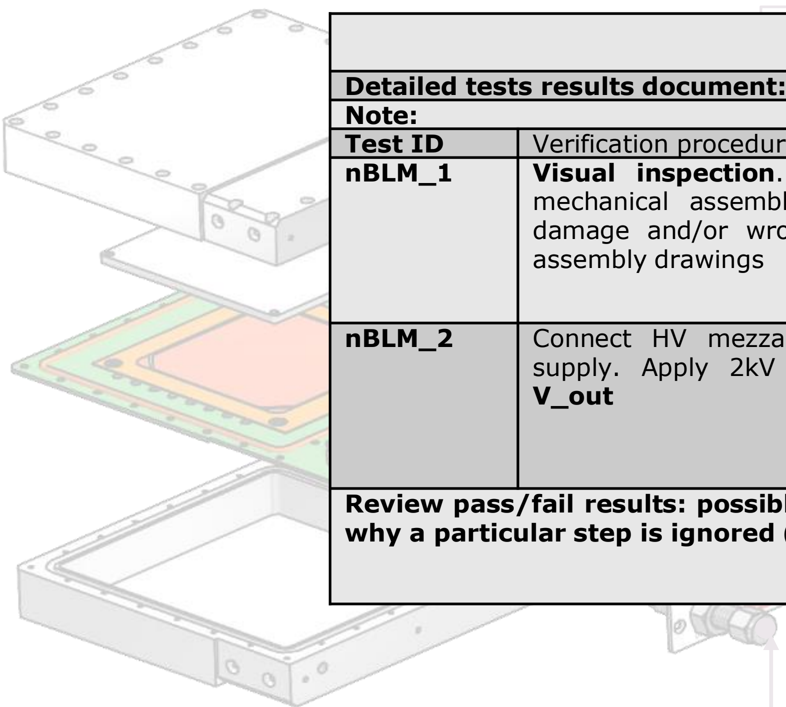
DETECTOR UNIT

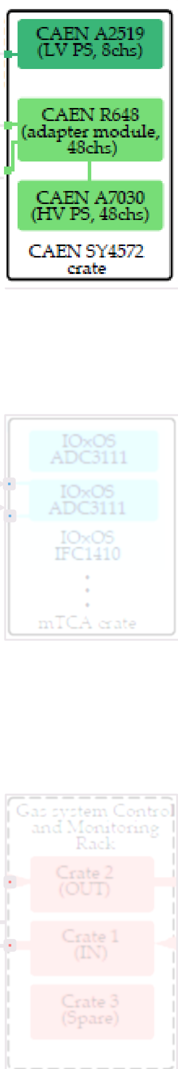


DETECTOR UNIT

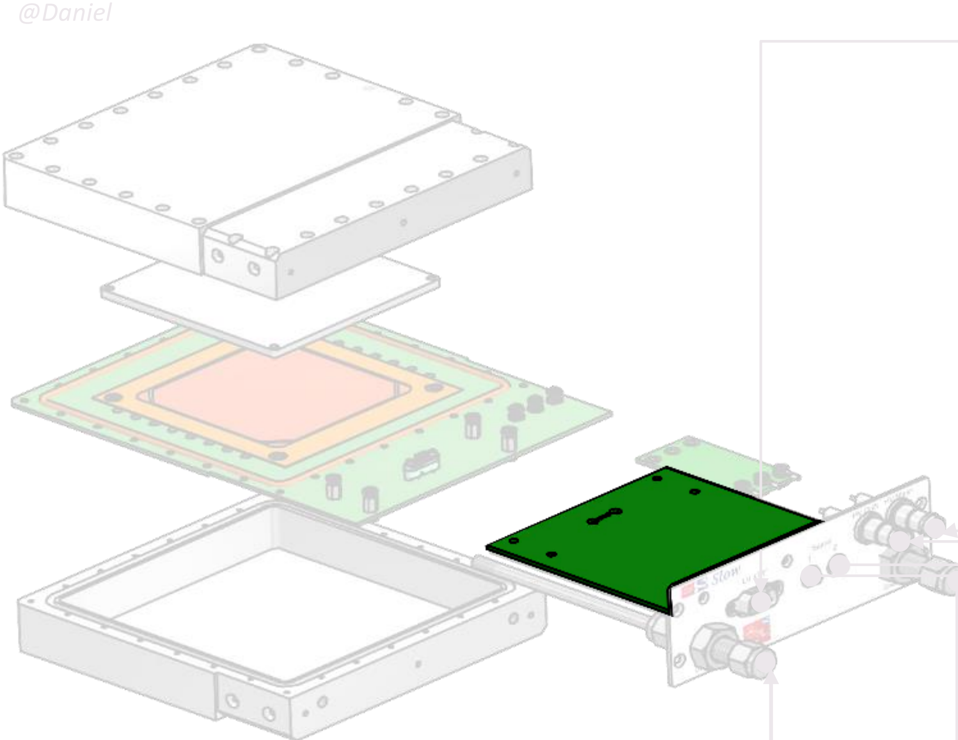
@Daniel

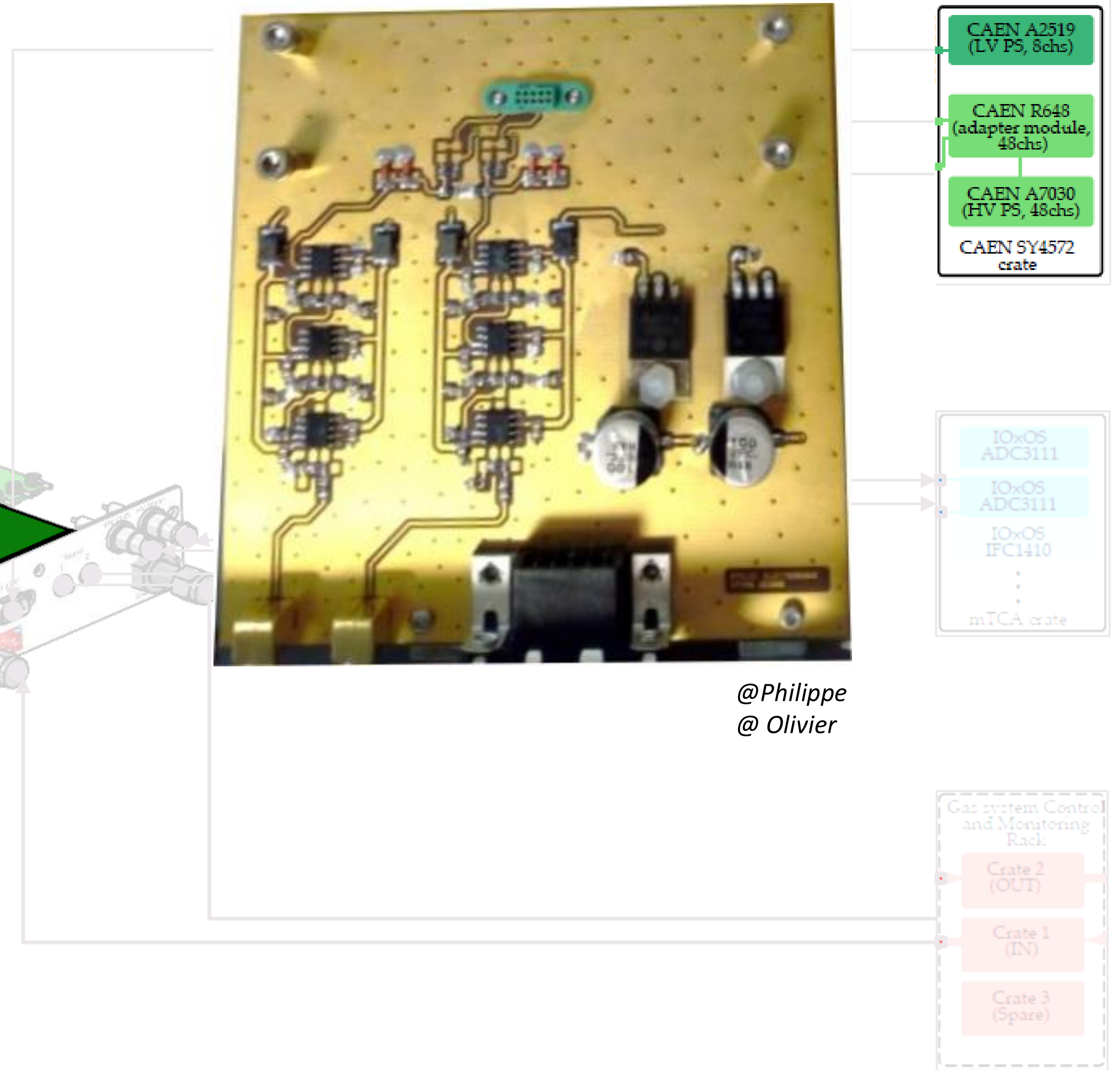
HV mezzanine card Part ID: NA				
Detailed tests results document: TBD				
Note:				
Test ID	Verification procedure	Threshold	Result	Pass / Fail
nBLM_1	**Visual inspection**. Check visually the mechanical assembly for any apparent damage and/or wrong assembly versus assembly drawings	No apparent damage		
nBLM_2	Connect HV mezzanine card to power supply. Apply 2kV at V_in , **readout V_out**	V_in = V_out		
Review pass/fail results: possible risks assessment when test is not passed etc. Explain why a particular step is ignored (if applicable)				





DETECTOR UNIT

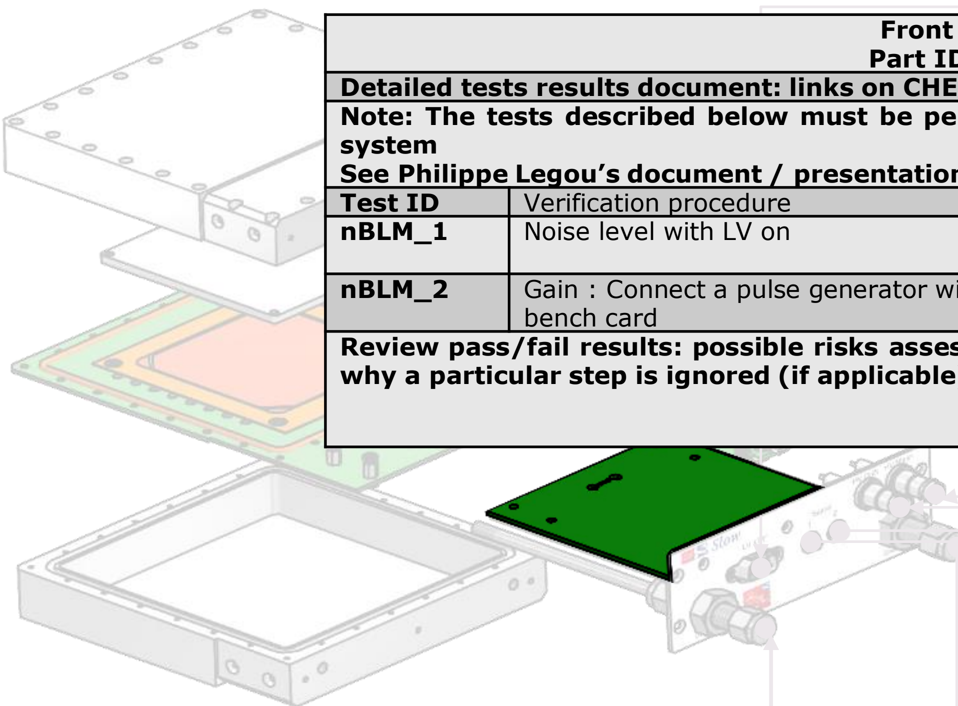


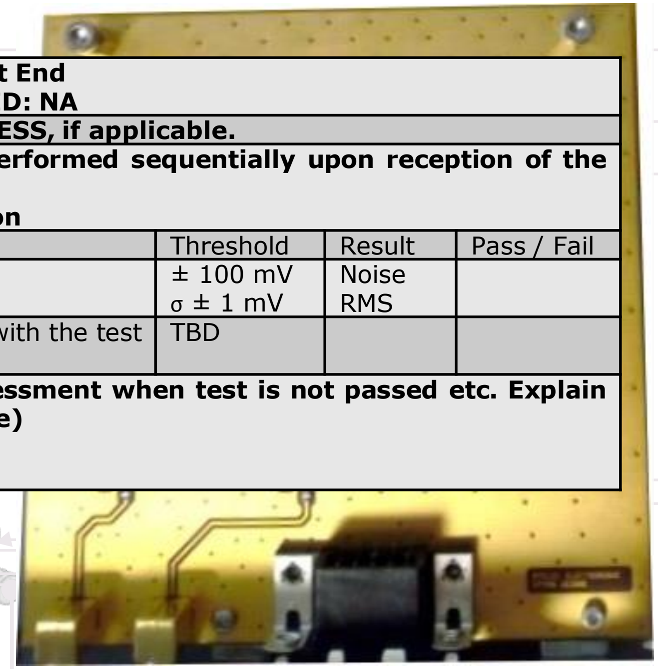


@Philippe
@ Olivier

DETECTOR UNIT

@Daniel

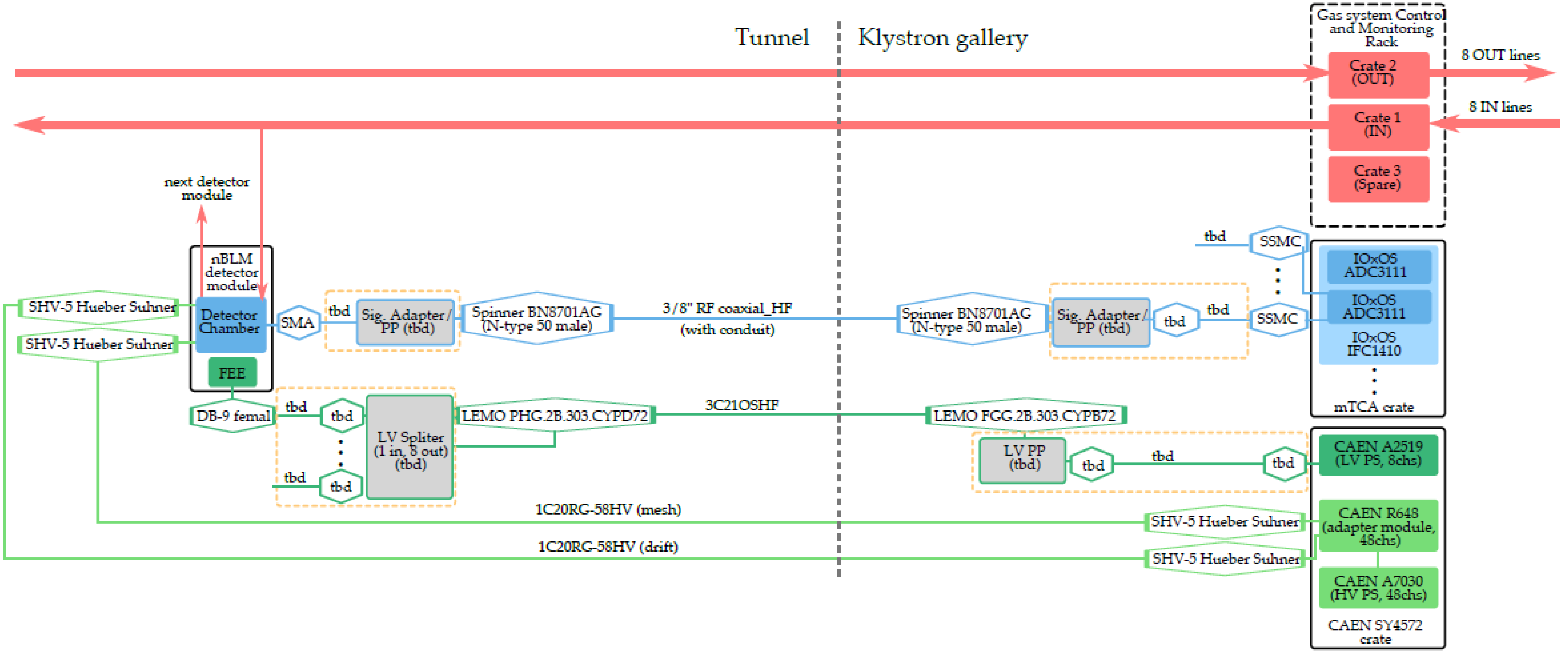




Front End Part ID: NA				
Detailed tests results document: links on CHESS, if applicable.				
Note: The tests described below must be performed sequentially upon reception of the system **See Philippe Legou's document / presentation**				
Test ID	Verification procedure	Threshold	Result	Pass / Fail
nBLM_1	Noise level with LV on	± 100 mV σ ± 1 mV	Noise RMS	
nBLM_2	Gain : Connect a pulse generator with the test bench card	TBD		
Review pass/fail results: possible risks assessment when test is not passed etc. Explain why a particular step is ignored (if applicable)				

@Philippe
@ Olivier

COMPLETE TEST WITHOUT SOURCE / BEAM

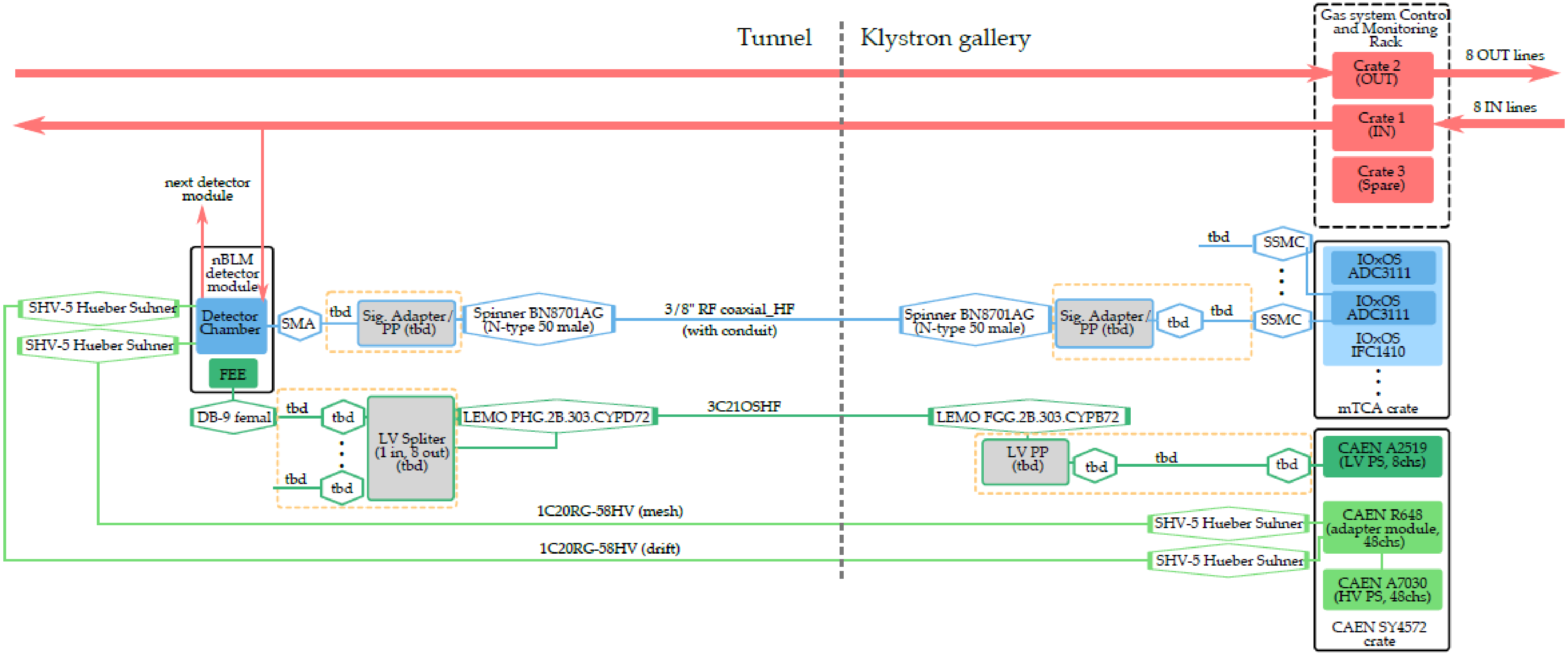


@Irena

COMPLETE TEST WITHOUT SOURCE / BEAM

Assembled system: detector box, uTCA electronics **Cold check out** **Part ID: NA**				
Detailed tests results document: links on CHESS, if applicable.				
Test ID	Verification procedure	Threshold	Result	Pass / Fail
nBLM_1	**Gas tightness** test with the gas distribution	TBD		
nBLM_2	Connect detector to the power supply, verify all electrical parameters at the OPI	TBD		
nBLM_3	For each detector box, Repeat nBLM_2 step	TBD		
Review pass/fail results: possible risks assessment when test is not passed etc. Explain why a particular step is ignored (if applicable)				

COMPLETE TEST WITH SOURCE



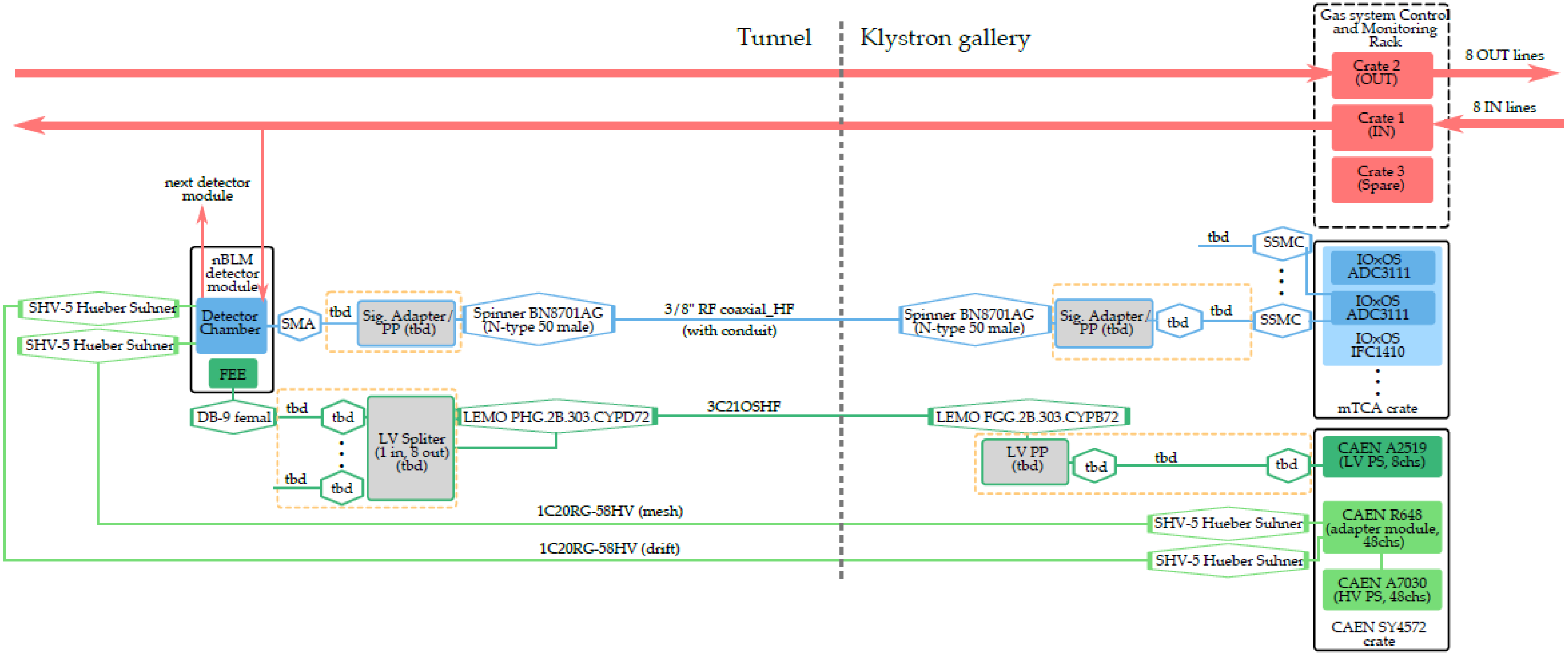
@Irena

COMPLETE TEST WITH SOURCE

System self-test (with a neutron source) **SW version: NA**				
Detailed tests results document: links on CHESS, if applicable.				
Test ID	Verification procedure	Threshold	Result	Pass / Fail
nBLM_1	Apply nominal voltages, and **check current**	<20 nA (above offset)		
nBLM_2	Analyze signal output, excitation is a neutron source, extract MPV (**Rise Time**). HV & LV on. Use a long signal cable, same as in tunnel	~30-50 ns		
nBLM_3	Analyze signal output, excitation is a neutron source, extract MPV (**Pulse width**). HV & LV on. Use a long signal cable, same as in tunnel	~100- 150 ns		
nBLM_4	Analyze signal output, excitation is a neutron source, extract MPV/mean (**Amplitude for the slow/fast**). HV & LV on. Use a long signal cable, same as in tunnel	TBD once nominal voltages are fixed		
nBLM_5	Count Rates for slow and fast placing the source at same position for all detectors	TBD by first calibration. Depends on the source		
nBLM_6	Additional possible tests: **Gain stability**. Depends on PT environmental variations. Under control conditions	Better than 10%		
nBLM_7	Additional possible tests: **Gain stability**. Depends on PT environmental variations. No control conditions	Better than 30%		
nBLM_8	**Baseline fluctuation (sigma)**	≤ 1mV		
Review pass/fail results: possible risks assessment when test is not passed etc. Explain why a particular step is ignored (if applicable)				

@Laura Thomas

COMPLETE TEST WITH BEAM



@Irena

COMPLETE TEST WITH BEAM

Tests with beam Part ID: NA				
Detailed tests results document: links on CHESS, if applicable.				
Test ID	Verification procedure	Threshold	Result	Pass / Fail
nBLM_1	Apply nominal voltages, and **check current**	<20 nA (above offset)		
nBLM_2	Analyze signal output, excitation is a neutron source, extract MPV (**Rise Time**). HV & LV on. Use a long signal cable, same as in tunnel	~30-50 ns		
nBLM_3	Analyze signal output, excitation is a neutron source, extract MPV (**Pulse width**). HV & LV on. Use a long signal cable, same as in tunnel	~100- 150 ns		
nBLM_4	Analyze signal output, excitation is a neutron source, extract MPV/mean **(Amplitude for the slow/fast**). HV & LV on. Use a long signal cable, same as in tunnel	TBD once nominal voltages are fixed		
nBLM_5	Tune **voltages** according to local rates	No sparks at normal beam conditions		
nBLM_6	**Dead time**	N/A		
nBLM_7	**Time response** for slow and fast	Fast (<10ns, immediate) Slow ~200 µs		
nBLM_9	Additional possible tests: **Gain stability**. Depends on PT environmental variations. Under control conditions	Better than 10%		
nBLM_10	Additional possible tests: **Gain stability**. Depends on PT environmental variations. No control conditions	Better than 30%		
nBLM_11	**Baseline fluctuation** (sigma)	≤ 1mV		
nBLM_12	Perform **pedestal** setting: The pedestal value must be set before all other settings. It is configured for each detector separately in two ways: • By checking the pedestal value monitored on the firmware level. • By histogramming the raw data extracted through the DoD feature.			

@Laura Thomas
@Irena Clément

COMPLETE TEST WITH BEAM

nBLM_13	Tune Neutron **algorithm settings**: To increase the statistic of detected neutrons, controlled losses are planned to be used to tune these values. The DoD feature is used to extract event amplitude and TOT together with rise time and charge distributions from either raw data or EventInfo data stream. The distributions serve as a guide to select the algorithm settings. Note that the settings must be tuned for each detector separately.		
nBLM_14	**Trigger delays** / Monitor accumulated loss (or neutron counts) over the beam pulse: (ie. loss over BEAM_ON period inside the pulse period) o For each trigger delay setting an average value for this loss is computed o Report the trigger setting with highest average value		
nBLM_15	**Monte Carlo Simulation verification** and equivalent loss scaling factor: o Define a set of controlled losses for simulation verification o Compare simulated and measured results. In case of larger discrepancies find the source and modify simulation model accordingly. o Once the simulation geometry model is verified, use the results to define scaling factors. ▪ For each detector connect number of lost protons to measure current for particular loss scenario. ▪ This gives a factor that can be used to calculate "equivalent lost protons" from the measurement during operation. Here each group of detectors has a loss scenario assigned to.		
nBLM_16	**Protection function commissioning** o Identify controlled loss scenarios with different loss time evolution (different time constants) o Produce these controlled losses to tune the protection algorithms		
nBLM_17	**MP thresholds** o Identify a few likely accidental scenarii that are most damaging o Use Monte Carlo simulations (Geant4) coupled with thermo-mechanical simulations (ANSYS) to understand damage potential. o Produce risk matrix which serves as a baseline to select MP thresholds.		

@Laura Thomas
@Irena Clément

CONCLUSION AND PERSPECTIVE

- Identity each subsystems / each tests for the validation ☒
- Realize the database ☐
- Define threshold / name of document ☐
- Define test bench / instruments needed at each step ☒

CONCLUSION AND PERSPECTIVE

Identity each subsystems / each tests for the validation	☒
Realize the database	*in the coming months*
Define threshold / name of document	*in the coming months*
Define test bench / instruments needed at each step	☒

The verification plan exists, needs to be completed

"Does it cover the system features required for first protons ?"

THANK YOU FOR YOUR ATTENTION